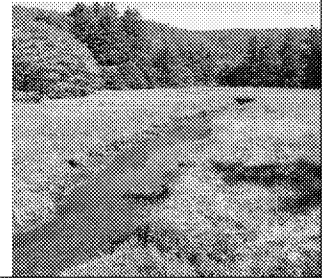
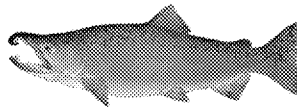


# Climate Change Effects on Water Quality & Biotic Endpoints in PNW Estuaries

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Region 10 – ORD  
July 7 2015



Today I am going to highlight some examples of WED's research focused on climate change effects on water quality and biotic endpoints specifically focusing on work in the PNW region.

## The earth's climate is changing and these changes are influencing estuarine & coastal ecosystems.

### Climate Drivers

Air Temperature  
Precipitation  
Wind  
Sea Level  
CO<sub>2</sub> Levels

### Estuary

Water Temperature  
Salinity  
Stratification  
Dissolved Oxygen  
Pathogens  
Algal Blooms  
Acidification

### Habitats

Water Column  
Seagrass  
Marsh  
Intertidal flats



Tools are needed to quantify how these drivers will impact coastal ecosystems and the ecosystem services they provide.

Scientific evidence is becoming increasingly clear, the earth's climate is changing and these changes are influencing estuarine and coastal ecosystems. Shown on the left are some of the climate drivers which influence conditions in estuaries. The drivers influence things like water temperature, salinity, stratification, dissolved oxygen, pathogen levels, algal blooms and also influence various habitats such as the water column, seagrass, marshes and intertidal flats. Tools are needed to quantify how these drivers will effect coastal ecosystems and the ecosystems services they provide. Today I am going to present some examples of our research including water temperature changes in estuaries, effects on seagrass, and wetlands.

# Precipitation and Streamflow



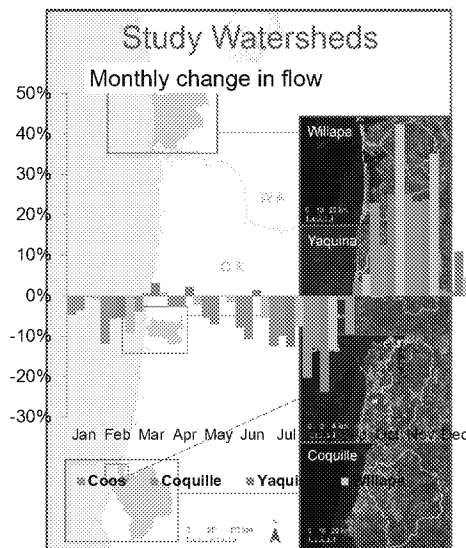
Prepared in cooperation with the U.S. Environmental Protection Agency and the Oregon Climate Change Research Institute

## Potential Climate-Induced Runoff Changes and Associated Uncertainty in Four Pacific Northwest Estuaries



Open-File Report 2012-1274

U.S. Department of the Interior  
U.S. Geological Survey

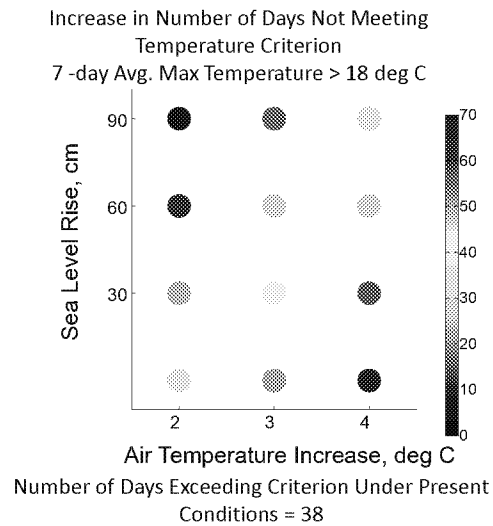


Through a collaboration with USGS and Oregon Climate Change Research Institute, we have quantified changes in precipitation and air temperature in four watershed and how these drivers will interact to influence freshwater inflow to these estuaries. We expect freshwater inflow to decline during July and August and will increase during the early fall. We are using these results to predict how these drivers will influence water quality and biota in the estuaries.

# Changes in Water Temperature

Temperature is the leading cause of impairments and is a key factor influencing water quality.

Modeling study to quantify the sensitivity of estuarine water temperature to climate drivers and attainment of water temperature criterion.



In the PNW, temperature is the leading cause of water quality impairments and is a key factor influencing the distribution and survival salmonids as well as water quality such as dissolved oxygen and pathogens. Similar to the study that Steve Klein presented for streams, water temperatures are expected to rise in estuaries as well. However, because estuaries are located at the interface of land and the ocean, the effects in the estuary will vary depending upon the magnitude of the climate drivers, location in the estuary and estuarine configuration. We conducted a modeling study to quantify the sensitivity of estuarine water temperature to climate drivers and what this would mean for attainment of water temperature criterion in the future.

These results may be useful for producing climate ready TMDLs for these systems.

In addition, we also examined what these temperatures increases would mean for oxygen and pathogen levels. Our modeling results were compared to threshold values in the literature and we found that small increases in estuarine water temperature may significantly increase exceedance of thermal threshold associated with the occurrence of a vibrio, which impacts shellfish aquaculture and has the potential to influence human health.

# Temperature and Nutrient Effects on Seagrass

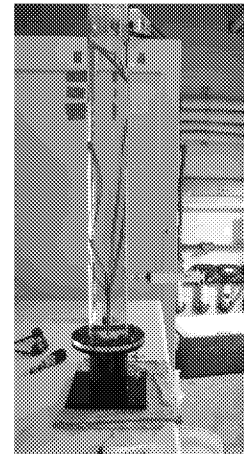
Seagrasses are often used as an indicator of nutrient enrichment but they are also sensitive to warming.

WED conducted a series of laboratory experiments to assess susceptibility of native seagrass to climate and nutrient drivers.

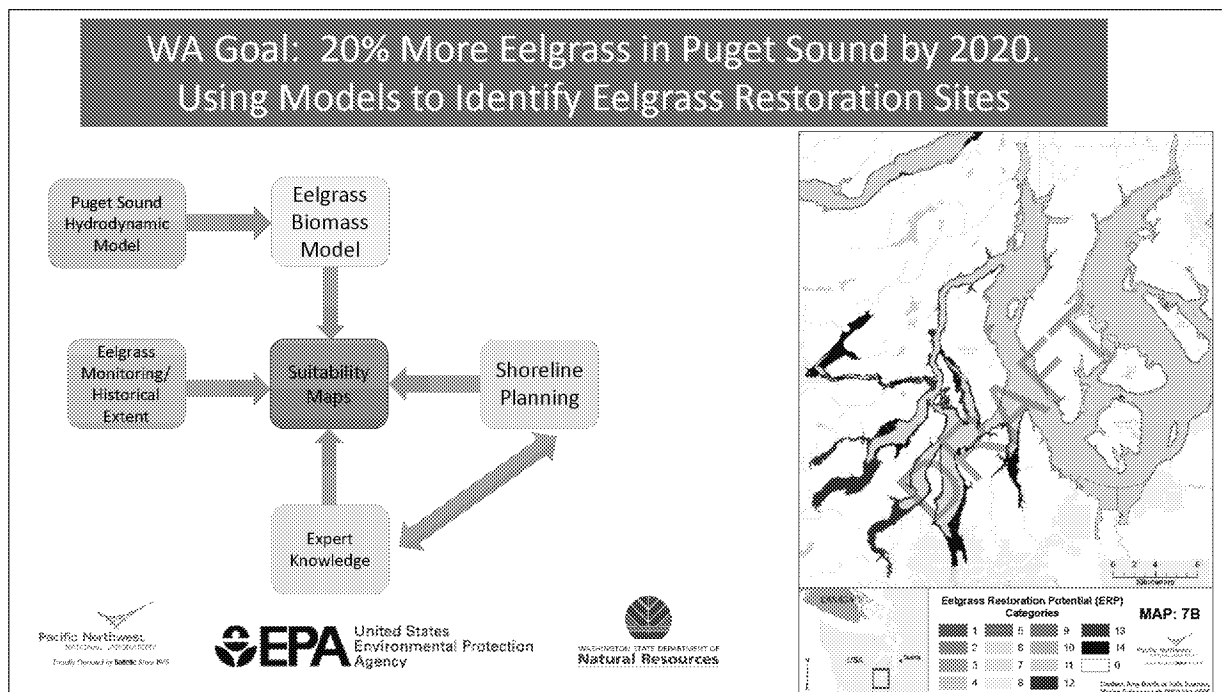
## Findings:

- Temperature dominates nutrient response
- No evidence of nitrogen toxicity
- Temperature and nitrogen effects do not appear to be synergistic
- Warming increased occurrence of wasting disease

**Impact:** Pacific Northwest *Z. marina* may be more sensitive to warming than nutrient enrichment.



There was a temperature effect and a nutrient effect but no interaction.



Washington State has set a goal of 20% more Eelgrass in Puget Sound by 2020.

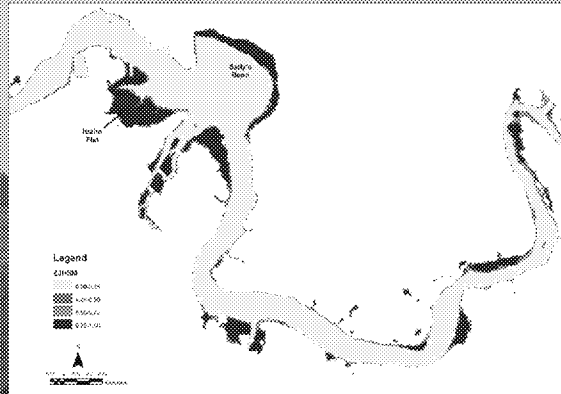
Through a MOU with PNW National Laboratory and in collaboration with WA DNR, models are being used to identify potential restoration sites that would help with achieving this goal. This work is funded in part by EPA through the Puget Sound Partnership

The eelgrass component of this model was developed at WED at Peter Eldridge and Jim Kaldy. Jim Kaldy continues to be involved in this effort, providing expertise on the eelgrass modeling component.

Climate change has the potential to influence restoration success.

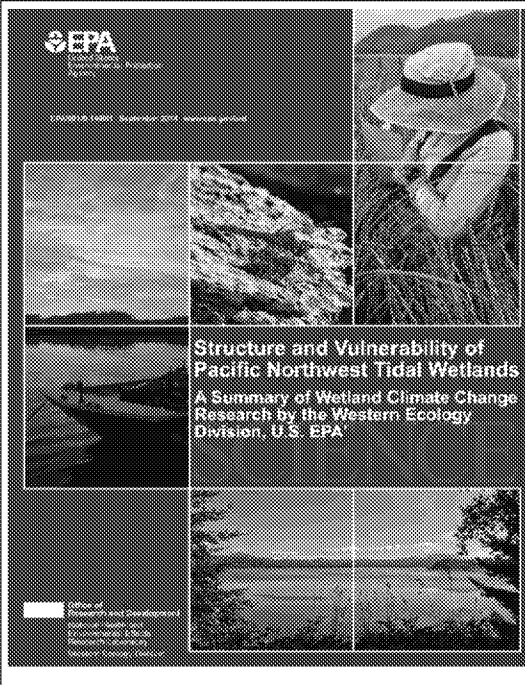
## Invasion Risk Modeling for Non-native seagrass (*Zostera japonica*) in Pacific Northwest

- Predict areas where non-native seagrass is likely to colonize
- Developed in Oregon.
- Ongoing work to validate in Puget Sound, 2015
- Long-term ( 9 year) collaboration with Army Corps Engineers through MOU
- Warming and sea level rise may cause an expansion of non-native seagrass.



In addition, to the native seagrass *Zostera marina* there is a non-native seagrass *Zostera japonica*. This non-native species has been increasing in estuaries along the Pacific coast and there is study that the presence of *Z japonica* decrease shellfish production. As a result, WA aquaculture industry has applied for permits to spray herbicides to limit *zostera japonica* in clam beds.

WED scientists have developed an invasion risk model that predicts the zonation and distribution of this non native plant. Model was developed for Yaquina Bay, OR and is currently being applied in Puget Sound as a validation study. We expect *Z japonica* to continue to increase it's colonization of unvegetated mudflats resulting in additional conflict between aquaculture and state resource managers.



Climate change will impact the distribution and composition of tidal wetlands.

WED has been conducting field & laboratory studies to quantify the changes that will occur in PNW tidal wetlands.

- Wetland extent and composition
- Plant response to sea level rise.
- Salinity response on germination.
- Response to nutrient additions.
- Indicators of wetland condition
- Quantifying ecosystem services

Sea Level Rise → Change in Wetland Area + Change in Wetland Species

Change in Production of Ecosystem Services

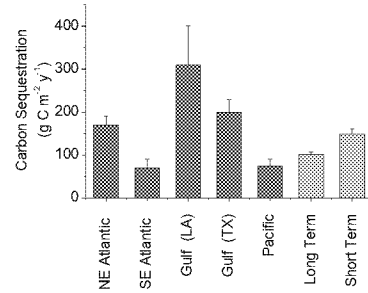
Series of 6 journal articles.

# Marsh Sedimentation and carbon sequestration

Key need to assess vulnerability to sea level rise is sedimentation rates.

WED is measuring sedimentation and carbon sequestration rates in Oregon salt marshes.

- Quantifying key drivers and methods to scale up results.



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**Carbon  
TradeXchange**  
Access the world's carbon markets

Member of Pacific Northwest Blue Carbon Working Group, which is exploring the feasibility of Blue Carbon Projects in the PNW as a means of supporting wetland restoration and conservation. Recently "Coastal Blue Carbon" was approved as a new international carbon trading category, which sets out the methods to quantify this ecosystem service and allows these benefits to be traded on carbon exchange.

## Conclusion

- Developing baseline information to help predict what will happen to biotic endpoints.
- Tools to inform management of coastal systems subjected to a changing climate.

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